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AUTHOR: SRyabyshkin, B.S.

TITLE: ©Dependence of the noise figure of a communications system on its design parameters

PERIODICAL: © Izvestiya vysshikh uchebnykh sevedeniy.
Radiotekhnika, v. 5, no. 6, 1962, 699 - 706

TEXT: A communications system (see Fig. 1) consisting of active elements Τ<sub>i</sub> (converters, amplifiers) and passive elements Τ<sub>j</sub> (transmission lines and paths, interstage networks, filter networks, etc.) is considered. The transfer function of the system is γ and its overall imertim loss due to the passive elements is:

 $G = \prod_{i=1}^{m+1} g_i$ 

Dependence of the noise figure ....

where  $g_i$  is the power-insertion loss introduced by a passive element  $J_i$  and m is the number of elements;  $K_i \ge 1$  is the Card 1/4

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power-amplification of the i-th active element. Under the assumption that the noise introduced by each passive element is  $\sigma_{T}^{2}$  and that of each active—element referred-to its input is  $\sigma_{T}^{2}$ , the noise power at the output of the system can be written as:

$$P_{0 \text{ mode}} = (P_{0} + \sigma_{1}^{2}) \frac{K_{0} K_{1} \cdots K_{m}}{g_{1} g_{0} \cdots g_{m+1}} + (\sigma_{1}^{2} + \sigma_{2}^{2}) \frac{K_{1} K_{2} \cdots K_{m}}{g_{0} g_{0} \cdots g_{m+1}} + \frac{K_{0} K_{1} \cdots K_{m}}{g_{1} g_{0} \cdots g_{m+1}} + \frac{K_{m}}{g_{m+1}} +$$

where  $P_{ij}$  is the noise power at the input of the system. It is seen from Eq. (4) that for  $K_{ij} = 1$  (where i = 1, 2, ..., m) the noise figure due to the design parameters is a minimum. The system of Fig. 1a can be simply represented by that of Fig. 15 under these conditions. The expression for the output noise is differentiated with respect to  $K_{ij}$  and m and it is found that Card 2/4

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Dependence of the noise figure ...

the minimum noise figure can be expressed as:  $N_{\min} = 1 + \frac{1}{P_{\text{a}}} \left[ e^{\frac{(\sigma_{\text{JJ}} + \sigma_{\text{T}}^2)}{K_{\text{O max}}}} \ln \left( \frac{G\gamma}{K_{\text{O max}}} \right) + \frac{\sigma_{\text{J}}^2}{\gamma} + \sigma_{\text{T}}^2 \right]$ (12)

where  $K_{o\ max}=P_{\square}/(P_a+o_T^2)$ , where  $P_{\square}$  is the permissible output power. For the case when  $P_a=P_{\square}$ ,  $K_{o\ max}=1$  and  $\gamma=1$ , it is found that the minimum noise figure is achieved when the transmission system is divided into equal sections in which the insertion loss of the passive elements and the gain of the active elements are equal to e=2.71; the number of active plus passive pairs is  $m=\ln G$ . The noise figure for  $\gamma=1$  and  $K_{o\ max}=1$  for any m is given by:

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Dependence of the noise figure ... E192/E382

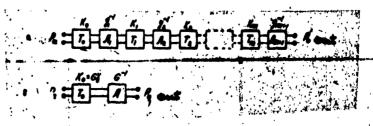
This expression permits evaluation of the deviation of the nodes figure from the optimum value. There are 6 figures.

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Fig. 1: